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14. (Amended) A semiconductor device comprising:

a substrate having a transistor;

an insulating film formed on the substrate and having an opening portion extending completely through said insulating film;

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a diffusion barrier film provided in the opening portion to extend completely through the insulating film, wherein said diffusion barrier film is connected to the transistor;

a reaction barrier film provided on the insulating film;

a first electrode electrically conducted to the diffusion barrier film;

a ferroelectric film provided on the first electrode and including at least one element selected from the group consisting of lead, barium and bismuth; and

a second electrode provided on the ferroelectric film.

REMARKS

Reconsideration and allowance of this application, as amended, is respectfully requested.

This amendment is in response to the Office Action dated June 20, 2001. By the present amendment, the title has been amended in response to the requirement set forth in paragraph 6 of the Office Action. Also, by the present amendment, independent claims 1, 7 and 14 have been amended to clarify the invention.

Reconsideration and allowance of claims 1-4 and 7-11 over the cited prior art to Fazan, Beach, Onishi, Okudaira and/or Ramesh, whether considered alone or in combination, is respectfully requested.

An embodiment illustrative of the invention defined in claims 1 and 7 can be seen in Figure 1 of the present application (noting that Figure 1 is cited solely for purposes of example, and is not intended to limit the invention solely to the details of Figure 1). For example, comparing Figure 1 with claim 1, an insulating film 32 is formed on a substrate 21 with a conductive film 42 formed in an opening portion of the insulating film 32. A capacitor is formed on the conductive film 42, wherein the capacitor comprises a first electrode 61, a ferroelectric film 71 and a second electrode 72. A reaction barrier film 43 is provided between the interlayer insulating film 32 and the ferroelectric film 71. In addition, in accordance with amended claims 1 and 7, the reaction barrier film 43 also is in contact with the lower surface of the first electrode 61. Therefore, as can be seen in Figure 1, the reaction barrier film 43 is interposed between the lower surface of the lower capacitor electrode 61 and the interlayer insulating film 32. In conjunction with this, a diffusion barrier film 51 (composed, for example, of TiN) is provided between the conductive film 42 and the first electrode 61, with the side faces of the diffusion barrier film 51 being kept out of contact with the ferroelectric film

71, while the side faces of the first electrode 61 are brought into contact with ferroelectric film 71.

Although the various references cited in the Office Action deal with diffusion barrier layers, reaction barrier layers, and ferroelectric films, it is respectfully submitted that none of them teach or suggest the claimed combination of feature set forth in the independent claims 1 and 7 regarding the use of a reaction barrier film provided not only between an interlayer insulating film and a ferroelectric film, but also between the lower surface of the capacitor electrode and the inner layer insulating film, in further combination with the recited diffusion barrier film. By virtue of this arrangement, not only does the reaction barrier film serve to suppress a reaction between the ferroelectric film and the interlayer insulating film, but also to suppress the diffusion of noble metal material from the lower capacitor electrode into the field oxide film. These combined features are achieved by the structure defined in the independent claims 1 and 7. Inasmuch as none of the cited references used in the rejection of claims 1-4 and 7-11 teach or suggest either the recited features of the amended claims 1 and 7 or the resulting advantages therefrom, reconsideration and removal of the rejection of claims 1-4 and 7-11 over these references is respectfully requested.

Reconsideration and allowance of claims 14-17 over the references to Fazan, Beach, Onishi, Okudaira and/or Ramesh is

also respectfully requested. Claim 14 defines an arrangement which can be appreciated by studying Figures 19-21 referring to the third embodiment described in the specification (again noting that these figure are cited solely for purposes of example, and are not intended to limit the invention solely to the specifics of these figures). It can be seen that the Figure 3 embodiment differs from the Figure 1 embodiment in terms of the arrangement of the diffusion barrier layer. In Figure 1, the diffusion barrier layer 51, composed, for example, of TiN, is interposed between the upper surface of a conductive film 42 and the lower surface of the capacitor electrode 61. In the third embodiment shown in Figure 19-21, on the other hand, a TiN layer 192 serving as a diffusion barrier is formed completely through the opening of the interlayer insulating film 191 between the lower surface of the capacitor electrode 194 and an upper contact to the transistor.

Figure 14 has been amended to clarify such a structure. In particular, claim 14 now defines:

"An insulating film formed on the substrate and having an opening portion extending completely through said insulating film;

A diffusion barrier film provided in the opening portion to extend completely through the insulating film, wherein said diffusion barrier film is connected to the transistor."

It is respectfully submitted that none of the cited references teach or suggest such a feature. On the contrary, these

various references disclose conductive plugs such as polysilicon plugs or tungsten plugs embedded in the insulator material, with the diffusion barrier layer then being formed on the conductive plug. As such, it is respectfully submitted that amended claim 14 and its dependent claims 15-17 clearly define over the cited prior art, and reconsideration and allowance of these claims, as amended, is respectfully requested.

Attached hereto is a marked-up version of the changes made to the claims by the current amendment. The attached page is captioned "Version with markings to show changes made."

If the Examiner believes that there are any other points which may be clarified or otherwise disposed of, either by telephone discussion or by personal interview, the Examiner is invited to contact applicants' undersigned attorney at the number indicated below.

It is respectfully requested that any shortage in the fee be charged to the account of Antonelli, Terry, Stout & Kraus, LLP, Account No. 01-2135 (Case No. 520.37546X00).

Respectfully submitted,

ANTONELLI, TERRY, STOUT & KRAUS, LLP

By



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Enclosure

Version With Markings to Show Changes Made

In the Claims:

Claims 1, 7 and 14 have been amended as follows:

1. (Amended) A semiconductor device comprising:

an insulating film formed on a substrate provided with a transistor and having an opening portion;

a conductive film formed in the opening portion; and

a capacitor formed on the conductive film and comprising a first electrode, a ferroelectric film and a second electrode;

wherein the ferroelectric film includes at least one element selected from the group consisting of lead, barium and bismuth and formed from above the first electrode to above the insulating film;

wherein a reaction barrier film is provided between the [interlayer] insulating film and the ferroelectric film, said reaction barrier film being in contact with a lower surface of said first electrode such that the reaction barrier film is interposed between the lower surface of the first electrode and said insulating film;

wherein a diffusion barrier film is provided between the conductive film and the first electrode and side faces of the diffusion barrier are not brought into contact with the ferroelectric film; and

wherein side faces of the first electrode are provided to be brought into contact with the ferroelectric film.

7. (Amended) A semiconductor device comprising:
a substrate provided with a transistor;
an insulating film formed on the substrate and having an opening portion;

a conductive film formed in the opening portion; and
a capacitor formed on the conductive film and comprising a first electrode; a ferroelectric film and a second electrode;

wherein the ferroelectric film includes at least one element selected from the group consisting of lead, barium and bismuth and formed on an upper face and side faces of the first electrode and on the insulating film;

wherein a reaction barrier film is provided between the [interlayer] insulating film and the ferroelectric film, said reaction barrier film being in contact with a lower surface of said first electrode such that the reaction barrier film is interposed between the lower surface of the first electrode and said insulating film; and

wherein a diffusion barrier film is provided between the conductive film and the first electrode and in the opening portion of the reaction barrier film.

14. (Amended) A semiconductor device comprising:

a substrate having a transistor;

an insulating film formed on the substrate and having an opening portion extending completely through said insulating film;

a diffusion barrier film provided in the opening portion to extend completely through the insulating film, wherein said diffusion barrier film is [and] connected to the transistor;

a reaction barrier film provided on the insulating film;

a first electrode electrically conducted to the diffusion barrier film;

a ferroelectric film provided on the first electrode and including at least one element selected from the group consisting of lead, barium and bismuth; and

a second electrode provided on the ferroelectric film.